

EM-RFO--KHLL-771OPS-2000-0057 FINAL

771 Operations
(Name of Facility)

Plutonium Processing and Handling
(Facility Function)

Rocky Flats Env. Technology Site Kaiser-Hill Company, L.L.C.
(Site) (Contractor)

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(Authorized Classifier (AC))

1. Occurrence Report Number: EM-RFO--KHLL-771OPS-2000-0057

Bioassay Results On Eleven Workers Above Decision Level

2. Report Type and Date: FINAL

	Date	Time
Notification:	12/01/2000	09:34 (MTZ)
Initial Update:	12/06/2000	10:51 (MTZ)
Latest Update:	10/24/2001	14:46 (MTZ)
Final:	10/25/2001	10:41 (MTZ)

3. Occurrence Category: Off-Normal

4. Number of Occurrences: 1 **Original OR:**

5. Division or Project: Kaiser-Hill Company, L.L.C.

6. Secretarial Office: EM - Environmental Management

7. System, Bldg., or Equipment: Building 771, Bioassay Results Above Decision Level

8. UCNI?: No

9. Plant Area: B771 Closure Project

10. Date and Time Discovered: 11/30/2000 17:00 (MTZ)

11. Date and Time Categorized: 11/30/2000 17:00 (MTZ)

12. DOE HQ OC Notification:

Date	Time	Person Notified	Organization
NA	NA	NA	NA

13. Other Notifications:

Date	Time	Person Notified	Organization
11/30/2000	17:35 (MTZ)		Rick Dion, DOE Fac Rep DOE/RFFO
11/30/2000	17:57 (MTZ)		Janet Decker, Investigator K-H

14. Subject or Title of Occurrence:

Bioassay Results On Eleven Workers Above Decision Level

15. Nature of Occurrence:

04) Personnel Radiological Protection
A. Radiation Exposure

16. Description of Occurrence:

On November 30, 2000, eleven Building 771 employees were requested to provide bioassay samples as a result of radiological documentation deficiencies that were discovered on October 16, 2000. The bioassay results for all but one employee have been determined to be above the decision level. The initial results estimated doses ranging from 110 millirem (mrem) to <1200 mrem.

The eleven workers were identified as working in Room 186 Tent in Building 771, during a 6-week period when Low-Volume Air Samples had not been documented.

BACKGROUND: On October 16, 2000, Building 771 reported an Off-Normal Occurrence under ORPS Report #RFO-KHLL-771OPS-2000-0053 when a Department of Energy Field Office Facility Representative, performing a routine surveillance, found an air sampler, in use in the 186 Tent, that had not been routinely calibrated according to procedure.

Upon further investigation, Facility Management discovered that the Low-Volume Air Sample Log sheets had not been filled out since September 7, 2000, for evolutions performed in the 186 Tent. Decontamination and Decommissioning (D&D) crews had performed size-reduction work in the Tent approximately 4-days a week since September 2, 2000. Radiation Safety Practice Procedures 3-PRO-160-RSP-04.02, AIR SAMPLING and 3-PRO-112-RSP-02.01, RADIOLOGICAL INSTRUMENTATION, require the evolution Radiological Control Technician (RCT) to record Derived Air Concentration (DAC) survey levels and equipment calibration dates after each use.

Without air contamination level documentation and sampling equipment possibly being out of calibration, the evolutions performed in the 186 Tent were uncharacterized for approximately 6-weeks. It was necessary to produce some type of dose re-construction records for the employees who worked in the Tent during the 6-week period. The Radiological Safety Department was assigned the action to develop a plan to re-create the potential conditions.

The Facility Radiological Safety Department was able to identify eleven employees who had worked in the 186 Tent during the 6-weeks in question. The workers were requested to submit bioassay samples to Internal Dosimetry for evaluation. The results of the samples would be used by the Radiological Safety organization to assign a dose to the eleven employees.

The samples were analyzed by Internal Dosimetry but the formula used to calculate dose levels required the date of the supposed exposure to complete the analysis. Since there was no specific date available the determination was made to use the mid-point of the 6-week period. This is the established, conservative policy when no event date is known.

EVENT: Bioassay sample results were returned on November 27, 2000, for the eleven workers. Using the mid-point date formula, all but one workers results were determined to be above the decision level. Three individuals with the highest results were given lung counts which came back with no detectable exposure. All original fecal samples were re-evaluated and additional samples were submitted by the ten employees.

Initial bioassay results returned on three of the workers identified much higher levels than expected and it was noted that all the workers performing evolutions during the 6-weeks were wearing respiratory protection and anti-contamination clothing. There was a possibility that the high exposure levels were the result of using the arbitrary mid-point date of exposure but before this could be confirmed, further investigation was necessary.

After reviewing the information gathered on the work done in the 186 Tent, it seemed unlikely that the bioassay result levels would be that high without some other event involved. With that in mind, the Facility Radiological Department

reviewed the work history of the three employees during the 6-weeks in question. It was identified that one of the three employees had been involved in an evolution to remove Zone 1 ducting and during that evolution a Continuous Air Monitor (CAM) had alarmed in an adjacent room. The duct removal evolution was approximately 36-hours before this worker submitted the first bioassay sample. The other two workers had nothing in their work history that would point to an event which could have caused the high levels. The second round of bioassay samples were still under review.

While the second samples were being analyzed, several other corrective actions were initiated in the Facility. On December 1, 2000, a Building Safety Pause was initiated and normal operations in Building 771 were not resumed until the following actions were completed. If it was necessary for workers to enter the contamination area (CA) to complete these corrective actions during the pause, respirators were worn by all employees:

1. Any volunteers for additional bioassay were allowed to submit their samples. This action is complete but further volunteers may come forward. (44 employees submitted samples)
2. Tape/Contain all the gloveboxes stored in the building awaiting disposal or size reduction. (Completed 12/11/00)
3. All staged gloveboxes were added to the routine survey program. (Completed 12/11/00)
4. Deliver preliminary dose results of the already identified exposed personnel. Lung counts were offered to all personnel who have sample results above the decision level. Any additional individuals associated with the 186 Tent evolution were asked to submit samples. (Completed - Additional samples will be reviewed when returned from the Lab.)
5. Job specific training was provided to each crew concerning compliance with the Integrated Work Control Program (IWCP)/procedures they were currently using. This included training on the specific Job Hazard Analysis (JHAs), As Low As Reasonably Achievable (ALARA) reviews, Radiological Work Permits (RWPs) and procedural steps. This action was documented on a training roster. (Completed 12/5/00)
6. A complete investigation by Radiological Engineering/Radiological Operations was conducted to identify the source of the unplanned exposures. This included a complete review of all fixed airhead samples for the preceding three months, a complete review of all CAM and Selected Alpha Air Monitor (SAM) alarms and logs for the preceding three months, a complete review of all air sampling trends for the three preceding months, a complete review of all DAC-hour tracing that was performed for the preceding three months, a complete review of all routine

surveys for the three preceding months, a complete review of the Configuration Control Authority (CCA) logbook for the three preceding months, and a complete review of the Radiological Operations logbook for the three preceding months. (Completed 12/5/00)

7. Tool Box training was conducted to re-emphasize good radiological work practices to properly taping and containing waste, and having an RCT present with the use of respiratory protection during the transport and disposal of line generated waste. (Completed 12/1/00)

8. Ensuring timely notification to the Joint Company Union Safety Committee (JCUSC) Co-chairman of all fact-finding meetings and manager's meetings. (Completed on December 5, 2000 the names of Co-chairman and other JCUSC members (not already included) were added to notification lists.)

9. A letter was issued to the project to educate the workforce including supervision on stop work/hold point language and rights. The letter also addressed proper ALARA principles with regard to breaks and idle time. (This actions was completed by a letter from the Project Manager to All Project Personnel under letter #KDT-116-00 "B771/774 Closure Project Stop Work/Break Time Policies" dated December 5, 2000.)

10. Project personnel were to investigate and if necessary re-contain overhead process lines that have been cut. (Completed 12/5/00)

11. Airflow re-testing was required after configuration changes are made in rooms. (Smoke tests done in Room 186 resulted in adding another CAM alarm. One additional CAM alarm was added at the step-off pad (laundry area)).

In addition to the above actions it was previously identified by the workers that an ill-fitting respirator, or the improper use of a respirator may be another cause of inhalations. In response to this concern the Facility made it mandatory for all workers to attend a refresher brief (held on 12/5/00) on respirator use before any work could be performed in the CA. The proper use of lapel worn air monitors was also included in the briefing. A requirement that a member of every crew wear a lapel monitor while performing intrusive work in the CA was implemented.

The Radiological Manager identified that due to the time involved in completing the listed corrective actions and additional data gathering underway, it would be several more weeks before a potential cause could be identified.

NOTE: With the completion of the above actions the Safety Pause was lifted on 12/11/00.

17. Operating Conditions of Facility at Time of Occurrence:

Normal Operations

18. Activity Category:

11 - Facility Decontamination/Decommissioning

19. Immediate Actions Taken and Results:

Further investigation of what might have caused the uptakes is underway. Additional Bioassay samples were taken and further bioassay analysis' were performed. An investigation team was chartered to try to determine the cause of the elevated results reported from the Internal Dosimetry Department.

20. Direct Cause:

8) Radiological/Hazardous Material Problem
A. Legacy Contamination

21. Contributing Cause(s):

22. Root Cause:

8) Radiological/Hazardous Material Problem
A. Legacy Contamination

23. Description of Cause:

The direct and root causes of this event were attributed to legacy contamination. It was concluded that the most likely cause of the positive bioassay results was exposure to low levels of airborne plutonium radioactivity from radiological work operations exacerbated by Decontamination and Decommissioning (D&D) Operations. The low levels of airborne radioactivity were below the threshold of workplace indicators.

Preliminary bioassay results, issued in late November 2000, showed unexpected levels of internal exposure in 10 of the 11 workers. To further quantify the results, 3 workers with the highest results were assayed using a lung counter. Results indicated exposures of less than the minimum sensitivity of the lung count analysis.

Rocky Flats site managers requested reanalysis of the initial bioassay samples, offered the opportunity for volunteers to provide fecal samples, suspended work in Building 771, and began a review to identify the source of the radioactivity that caused the positive fecal results. The management review identified numerous contamination control weaknesses for which compensatory measures were applied. However, a clear source for the internal depositions was not identified.

As the investigation progressed, additional waste workers and several individuals who provided voluntary fecal samples also showed positive fecal bioassay results. Results for nine of the original 11 workers are in the range of 6 millirem to 60 millirem, which is a 50-year committed effective dose equivalent. This equates to 0.12 to 1.2 millirem per year over a 50-year period.

Occurrence Report RFO-KHLL-771OPS-2000-0053, RAD DOCUMENTATION VIOLATION AND OTHER RAD PROGRAM CONCERNS, and this Occurrence, RFO-KHLL-771OPS-2000-0057, BIOASSAY RESULTS FOR ELEVEN WORKERS IN BUILDING 771, were self reported under Price Anderson Amendment Act Report NTS-RFO-KHLL-771OPS-2000-0003. A separate root cause investigation team was established for each occurrence and the final reports and corrective actions were combined in the NTS 2000-0003 report. The Investigation Team for this occurrence was chartered December 13, 2000, to investigate the source of internal radiological exposures involving 11 personnel in Building 771. The purpose of the investigation was to determine the cause or potential cause of the Building 771 worker exposures and to make recommendations to reduce recurrence in keeping with the Site's ALARA goals. Preliminary findings were communicated to the general workforce via Toolbox training sessions on February 16, 2001. The final report was submitted to DOE March 15, 2001.

The Investigation Team reviewed work histories of the personnel and reconstructed a timeline of their activities. Records and documents pertinent to Building 771 radiological safety, work controls and the site radiological safety program were reviewed. Personnel pertinent to the incident, building managers, and other support personnel, were interviewed. The following is an excerpt from the executive summary of the final report discussing the results and conclusions made by the Investigation Team.

Results of the Investigation: From the review of the timeline of possible inhalation events studied during the course of this investigation, there is no event in which all 11 workers were present and no series of events in which various groups of the workers could have received a single, large intake. An analysis was conducted of internal dosimetry results for the past six years. These results demonstrated that during airborne contamination incidents for which the workers were not contaminated and not wearing respirators, the individuals did not receive an intake resulting in a dose greater than a few millirem. Thus, it is extremely unlikely that the positive fecal results under investigation were due to an acute inhalation because an acute airborne contamination incident high enough to cause a detectable intake would have resulted in a Continuous Air Monitor (CAM) alarm. With one exception, all of the individuals stated that they were not in rooms in which a CAM alarmed when they were not wearing respirators.

In addition, the Investigation Team conducted an analysis to determine the average, steady-state level of airborne contamination throughout Building 771 from January 28, 2000 to January 19, 2001. Breathing the average air within Building 771 for 25 hours per week would result in an annual internal dose of 4 millirem. Since the dose range identified was between 6 millirem and 60 millirem, it is therefore extremely unlikely that intakes occurred due to slightly elevated, ambient airborne radioactivity in Building 771.

The Investigation Team reviewed studies from the Hanford and Savannah River sites that revealed internal plutonium exposures could be detected in scheduled fecal examination in the absence of workplace indicators such as personnel contamination or airborne radioactivity alarms. The rates of positive (above background) fecal results in the two studies were comparable to the overall results seen in Building 771. Air samples at Hanford were consistent with those at Rocky Flats.

The Hanford study indicated that the fecal bioassay results changed with time depending on the work being performed (e.g., maintenance and repair versus routine processing operations). Since the weekly air sample results in Building 771 appear to fluctuate with the number of radiological work hours logged, it can be expected that the Rocky Flats intakes will follow a similar pattern. Therefore, the fecal values seen at Building 771 are most likely to be the result of a series of small, acute events and/or a series of small, chronic exposure periods, interrupted by weekends, holidays, training, etc. These intakes have been modeled as "effective" chronic intakes.

The fecal sampling in Building 771 revealed that workers were incurring very low-level intakes below the threshold of workplace monitoring systems. Results for nine of the original 11 workers are in the range of 6 millirem to 60 millirem, which is a 50-year committed effective dose equivalent. This equates to 0.12 to 1.2 millirem per year over a 50-year period.

Conclusion and Judgement of Need: D&D activities such as those currently under way at Building 771 are vastly different from many other radiological activities normally encountered in the DOE complex. The destructive nature of D&D activities can produce localized contamination and airborne radioactivity. When D&D activities take place in facilities contaminated with plutonium, the challenges to a radiation safety program are especially great. Workplace indicators are not capable of detecting low levels of plutonium contamination in equipment and materials or as airborne radioactivity.

In addition, urinalysis and lung counting do not have the sensitivity necessary to detect intakes of plutonium at the DOE investigation level of 100 millirem. While the analysis of fecal samples does offer the necessary sensitivity, fecal sampling is not used routinely at Rocky Flats because compliance of the workforce is difficult to maintain and interpretation of results without a known intake event is

very difficult. Fecal examination is required when workplace indicators signal the possibility of internal deposition of radionuclides.

In summary, the Investigation Team concluded that the most likely cause of the positive bioassay results was exposure to low levels of airborne plutonium radioactivity from radiological work operations exacerbated by D&D operations. These low levels of airborne radioactivity are below the threshold of workplace indicators.

While the exposure to individuals from these intakes were well within regulatory limits, the critical nature of the investigation into positive fecal results from workers from Building 771 identified several areas for improvement that could contribute to maintaining exposures to the Site's As Low As Reasonably Achievable goals.

Three of the improvements/actions identified are listed below: 1. Modify Radiological Work Practices to require respiratory protection in situations involving direct waste handling also, post rooms as airborne radioactivity areas when work in adjacent rooms could dislodge contamination and affect co-located workers. (Completed 8/9/2001) 2. Revise radiological safety procedures to require weekly radiological surveys for removable contamination on staged equipment and components that are pending size reduction. Improved containment and require weekly surveys of items staged for size reduction. (Completed 6/12/01) 3. Increase total ventilation airflow within the Building to maximum practical. If unable to increase airflow, then increase filtration through the use of air movers. (Completed 7/12/2001)

In addition to the corrective actions and improvements included in this report and also as part of a March 14, 2001 Root Cause Analysis on Building 771 Radiological Safety Program Concerns, the Root Cause Analysis Team identified several other corrective actions. As previously stated, these and additional corrective actions are included and will be tracked in the Plant Action Tracking System under the Price-Anderson Amendments Act (PAAA) report #NTS-RFO-KHLL-771OPS-2000-0003.

In conclusion, even with these improvements and other robust controls for contamination in place and also the highest attainable compliance with protective processes and procedures, some level of internal exposure to radionuclides will most likely occur in individuals who are directly involved in high-risk activities associated with the decontamination and decommissioning of Rocky Flats former plutonium processing facilities.

24. Evaluation (by Facility Manager/Designee):

Even though these bioassay results were attributed to very low-level exposures of plutonium that were caused by the performance of D&D activities, personnel

must continue to use good radiological work practices to prevent exposures and the spread of contamination. It is imperative that personnel adhere to ALARA principals and follow radiological procedures.

25. Is Further Evaluation Required?: No

26. Corrective Actions (* = Date added/revised since final report was approved.)

1. Initiate a Safety Pause Friday, December 1, 2000, and complete the eleven corrective actions during the pause.

Target Completion Date: 12/14/2000 **Completion Date:** 12/11/2000

2. Update the 186 Tent RWPs to include, "perform nasal samples and wear lapel air samplers during D&D evolutions".

Target Completion Date: 12/14/2000 **Completion Date:** 12/11/2000

3. Brief crews on monitoring their PAPR respirators prior and during D&D evolutions.

Target Completion Date: 12/14/2000 **Completion Date:** 12/05/2000

4. To maintain exposures to the Site's As Low As Reasonably Achievable goals, three improvements / actions were: 1. Modify Radiological Work Practices to require respiratory protection in situations involving direct waste handling also, post rooms as airborne radioactivity areas when work in adjacent rooms could dislodge contamination and affect co-located workers. (Completed 8/9/2001) 2. Revise radiological safety procedures to require weekly radiological surveys for removable contamination on staged equipment and components that are pending size reduction. Improved containment and require weekly surveys of items staged for size reduction. (Completed 6/12/01) 3. Increase total ventilation airflow within the Building to maximum practical. If unable to increase airflow, then increase filtration through the use of air movers. (Completed 7/12/2001)

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Target Completion Date: 08/09/2001 **Completion Date:** 08/09/2001

27. Impact on Environment, Safety and Health:

All radiological equipment was accounted for and the required calibrations were performed. The 186 Tent air samplers were checked and were found to be within tolerance, no re-adjustments were required. This indicated that even though the calibration time period had expired, the monitor had been working properly.

The cause investigation team for the potential intakes concluded that the most likely cause of the positive bioassay results was exposure to low levels of airborne plutonium radioactivity from radiological work operations exacerbated by D&D operations. These low levels of airborne radioactivity were below the threshold of workplace indicators.

The environment and the health and safety of the public and other plant personnel was not threatened.

28. Programmatic Impact:

This event cause schedule delays due to a Facility work pause. Work in the affected tent was suspended from December 1, 2000 through December 11, 2000. The work crew spent and 10-day pause performing radiological characterizations of the contamination area, (i.e., smoke testing, overhead rad surveys, building housekeeping)

29. Impact on Codes and Standards:

As a result of this occurrence, a Price Anderson Amendment Act Report was filed under #NTS-RFO-KHLL-771OPS-2000-0003. The DOE Office of Price-Anderson Enforcement concluded that the Code of Federal Regulation 10 CFR 835, "Occupational Radiation Protection" was violated by this event and a monetary civil penalty was imposed.

30. Lessons Learned:

When D&D activities take place in facilities contaminated with plutonium, the challenges to maintain radiological safety are great. Workers need to be aware and expect potential hazards. The need for workers to follow established radiological safety control procedures is essential when removing old plutonium contaminated equipment.

31. Similar Occurrence Report Numbers:

RFO-KHLL-771OPS-2000-0053 RFO-KHLL-771OPS-2000-0047

32. User-defined Field #1:

000716 ISM=N/A

33. User-defined Field #2:

05/03/2001 08/01/2001 09/28/2001 11/30/2001

34. HQ Keyword(s):

01H--Conduct of Operations - Missed/Late Surveillance 01J--Conduct of Operations - Operations Procedure 06H--Radiological Issues - Intake (Start Feb 99)

35. HQ Summary:

36. DOE Facility Representative Input:

37. DOE Program Manager Input:

38. Approvals:

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